

UTILITY  
PATENT APPLICATION  
TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No. P99,2094

First Named Inventor or Application Identifier

Satoshi Kitayama et al,

Express Mail Label No:

ADDRESS TO: Assistant Commissioner for Patents  
Box Patent Application  
Washington, DC 20231

jc675 U.S. PTO  
09/453592  
12/03/99

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

1. ☒ Specification [Total Pages 13 ]  
2. ☒ Drawing(s) (35USC 113) [Total Pages 7 ]  
3. ☒ Declaration and Power of Attorney [Total Pages 2 ]  
a. ☐ Newly executed declaration (Original copy)  
b. ☐ Copy from prior application (37CFR 1.63(d))  
(for continuation/divisional with Box 14 completed)  
i. ☐ [Note Box 4 Below]  
DELETION OF INVENTOR(S)  
Signed statement attached deleting  
inventor(s) named in the prior application,  
see 37 CFR 1.63(d)(2) and 1.33(b).  
4. ☐ Incorporation By Reference (usable if Box 3b is checked)  
The entire disclosure of the prior application, from which a  
copy of the oath or declaration is supplied under Box 3b,  
is considered as being part of the disclosure of the  
accompanying application and is hereby incorporated by  
reference therein.

ACCOMPANYING APPLICATION PARTS

5. ☐ Assignment Papers (cover sheet & documentation)  
6. ☒ Letter under 37 CFR 1.41(c).  
7. ☐ English Translation Document (if applicable)  
8. ☐ Information Disclosure Statement (IDS)/PTO-1449 ☐ Copies of IDS Citations  
9. ☒ Preliminary Amendment  
10. ☒ Return Receipt Postcard (MPEP 503)  
(Should be specifically itemized)  
11. ☐ Small Entity ☐ Statement filed in prior application,  
Statement(s) Status still proper and desired  
12. ☒ Certified Copy of Priority Document(s) Japanese  
Application No. P10-345559 filed December 4, 1998  
13. ☐ Other:

14. If a CONTINUING APPLICATION, check appropriate box and supply the requisite information:

☐ Continuation ☐ Divisional ☐ Continuation-in-part (CIP) ☐ of prior application No: 1

CLAIMS AS FILED

(1) FOR	(2) NUMBER FILED	(3) NUMBER EXTRA	(4) RATE	(5) BASIC FEE \$760.00
TOTAL CLAIMS 20	5			
INDEPENDENT CLAIMS 3	1			
	ANY MULTIPLE DEPENDENT CLAIMS? (YES (X) NO			
			TOTAL FILING FEE ->	\$760.00

☒ The Commissioner is hereby authorized to charge any additional fees which may be required in connection with this application, or credit any overpayment to ACCOUNT NO. 08-2290. A duplicate copy of this sheet is enclosed.

☒ A check in the amount of \$ 760.00 to cover the filing fee is enclosed.

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December 1, 1999

Hon. Assistant Commissioner for Patents  
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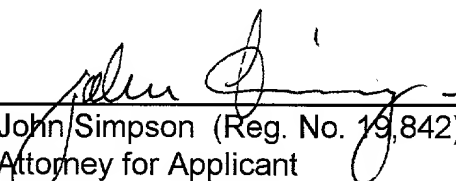
Re: Proposed Patent Application for SATOSHI KITAYAMA, KAZUSHIGE  
NIGAWARA and TAKESHI SASAKI entitled "PHOTOELECTRIC  
CONVERTER", Attorney Docket No. P99,2094

S I R:

Under the provisions of 37 CFR § 1.41 (c), I am filing the attached application with 5 claims, 7 sheets of informal drawings and filing fee on behalf SATOSHI KITAYAMA, KAZUSHIGE NIGAWARA and TAKESHI SASAKI and request that the application papers be assigned a serial number and filing date.

I request that the application be assigned a Serial No. and Filing Date pursuant to the provisions of 37 C.F.R. § 1.53(b) and 37 C.F.R. § 1.53(f).

Respectfully submitted,

  
\_\_\_\_\_  
John Simpson (Reg. No. 19,842)  
Attorney for Applicant

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

**PRELIMINARY AMENDMENT ACCOMPANYING APPLICATION**

APPLICANT: SATOSHI KITAYAMA ET AL

ATTORNEY DOCKET NO.  
P99,2094

SERIAL NO.:

DATE FILED: (filed concurrently herewith)

INVENTION: **PHOTOELECTRIC CONVERTER**

Assistant Commissioner of Patents and Trademarks  
Washington DC 20231

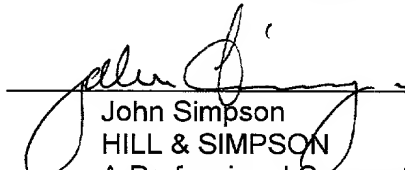
S I R:

Between the title and the heading "Background of the Invention" on page 1,  
insert the following:

--RELATED APPLICATION DATA

The present application claims priority to Japanese Application No. P10-345559  
filed December 4, 1998 which application is incorporated herein by reference to the  
extent permitted by law.--

Respectfully submitted,

  
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599P13904500

# PHOTOELECTRIC CONVERTER

## BACKGROUND OF THE INVENTION

### Field of the Invention

The present invention relates to a photoelectric converter such as an imaging apparatus employing photoelectric conversion devices such as photodiodes.

### Description of Related Art

An imaging apparatus has a number of pixels formed in an imaging area (a light receiving portion) thereof receive light signals from a subject, photoelectrically converts the light signals into signal charges, transfers the converted electric signals, thereby imaging the subject.

Fig. 7 shows a CCD imaging apparatus as an example of an imaging apparatus.

Light incident on a photodiode 1 is photoelectrically converted into a signal charge, the signal charge is read out to a vertical CCD portion 3 via a readout gate 12A, the signal charge is transferred by supplying transfer clocks of, e.g.  $\phi V1$  to  $\phi V4$  to the vertical CCD 3, and the signal charge is directed to an output portion in a horizontal CCD portion to which transfer clocks of, e.g.  $\phi H1$  and  $\phi H2$  are supplied, where

charge voltage conversion and the like are performed to produce an image signal.

By the way, recent imaging apparatuses, particularly a CCD (charge coupled device) imaging apparatus and the like, tend to have more compact unit cells and increase the amount of charges stored in a sensor to improve sensitivity.

For this reason, it is becoming difficult to read out charges into a vertical CCD, which is a charge transfer portion, from a photodiode comprising a light receiving portion (pixel portion) via a gate portion.

Particularly, as shown in Figs. 4A and 4B, in the case of an imaging apparatus in which the horizontal size of a unit cell comprising a photodiode portion 1 and a gate portion 2 is longer than the vertical size, it is more difficult to read out charges into a vertical CCD portion 3. Fig. 4A shows a schematic layout of the unit cell from which the vertical CCD portion is excluded, and Fig. 4B shows a schematic layout of the unit cell including the vertical CCD portion (hereinafter the same is also true of other drawings).  $L_{2-1}$  or  $W_1$  in the drawings is the width of a readout gate 2A and  $L_{1-1}$  is the width of a gate 2B which is not related to readout. The reference numeral 4 designates a channel stopper for

separating unit cells.

To solve such a problem, the following two measures are taken. One is, as shown in Figs. 5A and 5B, to enlarge the readout gate width (gate length in a direction orthogonal to a carrier travel direction: the same is true of the following descriptions)  $L_{2-2}$  or  $W_2$  of a readout gate portion 2A (indicated by white background or oblique lines) of the gate portion 2. The other is, as shown in Fig. 6A and 6B, to reduce a readout gate length (gate length in a carrier travel direction: the same is true of the following descriptions)  $l_{1-3}$ .

However, in the layouts of Figs. 5A and 5B, a ratio between the two gates of the vertical CCD portion 3, that is, a gate 2A to read out charges and a gate 2B which is not related to readout, is different. Consequently, the charge capacity of the vertical CCD portion is liable to become small or charges are liable to be unsuccessfully transferred.

In the layouts of Figs. 6A and 6B, the gate 2 itself fails to play the role of a barrier during off operation, with the result that charges leak from the photodiode portion 1 to the vertical CCD portion 3 or light passes between a silicon film and a shielding film (both are not shown) below the gates, and photoelectric

conversion may occur within the vertical CCD portion 3.

#### SUMMARY OF THE INVENTION

The present invention has been made in view of the above situation, and its object is to provide a photoelectric converter such as an imaging apparatus which smoothly reads out charges without influencing the charge capacity and charge transfers of a charge transfer portion and can reduce power consumption by reducing a readout voltage.

Specifically, a photoelectric converter of the present invention comprises a light receiving portion, a gate portion, and a charge transfer portion, wherein the gate width of the gate portion is wider at the light receiving portion side than at the transfer portion side.

Thus making a gate width wider at a light receiving portion side than at a charge transfer portion side helps to enlarge an area of an electric field applied to the gate in an area to admit charges from the light receiving portion (accordingly, the electric field of the gate area can be intensified), with the result that charges can be easily read, and if a readout capacity is the same, a charge readout voltage can be reduced to reduce power consumption. Yet, since such an effect can be achieved

without changing a gate width at the charge transfer portion side, no influence is exerted on the charge capacity and charge transfers of the charge transfer portion and other characteristics also do not deteriorate.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Figs. 1A and 1B show main portions of an imaging apparatus in a first embodiment of the present invention; Fig. 1A is a layout diagram centered on a gate portion, and Fig. 1B is a layout diagram of a unit cell.

Figs. 2A and 2B show main portions of an imaging apparatus in another embodiment of the present invention; Fig. 2A is a layout diagram centered on a gate portion, and Fig. 2B is a layout diagram of a unit cell.

Figs. 3A and 3B show main portions of an imaging apparatus in yet another embodiment of the present invention; Fig. 3A is a layout diagram centered on a gate portion, and Fig. 3B is a layout diagram of a unit cell.

Figs. 4A and 4B show main portions of a conventional imaging apparatus; Fig. 4A is a layout diagram centered on a gate portion, and Fig. 4B is a layout diagram of a unit cell.

Figs. 5A and 5B show main portions of another conventional imaging apparatus; Fig. 5A is a layout



diagram centered on a gate portion, and Fig. 5B is a layout diagram of a unit cell.

Figs. 6A and 6B show main portions of yet another conventional imaging apparatus; Fig. 6A is a layout diagram centered on a gate portion, and Fig. 6B is a layout diagram of a unit cell.

Fig. 7 shows a CCD imaging apparatus as an example of an imaging apparatus.

#### DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention is preferably constructed as an imaging apparatus in which the light receiving portion has pixels comprising photodiodes and the like, and the charge transfer portion comprises charge coupled devices.

As to the shape of the gate portion, although there are no special limitations thereon, preferably, the gate width is narrower from the light receiving portion toward the transfer portion straightly, curvedly, or gradually.

Furthermore, preferably, the gate portion comprises a first gate portion the gate width of which is narrower from the light receiving portion toward the transfer portion, and a second gate portion provided with an identical gate width from the first gate portion further toward the charge transfer portion.

Hereinafter, the present invention will be described more specifically based on an embodiment of the present invention applied to a CCD imaging apparatus.

Figs. 1A and 1B show main portions of a CCD imaging apparatus; Fig. 1A is a layout diagram primarily showing a configuration of a gate portion, and Fig. 1B is a layout diagram primarily showing a configuration of a light receiving portion including a vertical CCD portion (hereinafter, the same is also true of other drawings).

In Figs. 1A and 1B, the numeral number 1 designates a photodiode portion surrounded by a channel stopper portion 4, interpixel portions 5, and a gate portion 12, and the gate portion is adjacent to a vertical CCD portion 3.

In this embodiment, the CCD imaging apparatus is constructed so that a part of a gate 12B of the gate 12 which is not related to charge readout is cut in a slanted line form from a corner of the photodiode portion 1 to the vertical CCD portion 3, as opposed to the gate portion 2 of Figs. 4A and 4B, whereby the width  $L_{2-5}$  or  $W_4$  of a gate portion 12a of a readout gate 12A adjacent to the photodiode portion 1 is widened up to the same width as that of the photodiode portion 1 and the width  $L_{2-4}$  or  $W_4'$  of a gate portion 12b of the readout gate 12A and the

gate length  $l_{1-4}$  at the vertical CCD portion 3 side is unchanged ( $l_{1-4} = l_{1-1}$ ).

Light from a subject is photoelectrically converted in the photodiode portion 1 and thereby (signal) charges are generated. Applying a voltage to the gate portion 12 (the gate portion 12A goes on) causes the charges of the photodiode portion 1 to be read out to the vertical CCD portion 3 by the readout gate portions 12a and 12b.

The CCD imaging apparatus employs two types of gates, gate portions 12A and 12B. One of them is a gate used during charge readout, and the other is a gate not used for charge readout, placed below the former. In a portion where the two gate overlap, the gate not related to readout is dominant.

This embodiment is characterized in that a gate not related to charge readout is cut in a slanted line form as described above and the width  $L_{2-5}$  or  $W_4$  of the readout gate portion 12a adjacent to the photodiode portion 1 is widened, so that an electric field applied to that portion is intensified during activation so that charges within the photodiode portion 1 can be easily read out.

Owing to the gate pattern, the gate width  $L_{2-4}$  or  $W_4'$  at the vertical CCD portion 3 side is the same as conventional ones. Therefore, a gate width adjacent to

the vertical CCD portion 3 can be maintained to an optimum width for the charge capacity and charge transfer efficiency of the vertical CCD portion 3 without influencing the charge capacity and charge transfers of the vertical CCD portion 3 and deteriorating other characteristics. Also, since a charge readout voltage is reduced by widening a gate width as described above, power consumption can be reduced. Yet, since the read gate length  $l_{1-4}$  is unchanged, the gate serves, during off operation, as an adequate barrier against charges so that there is no leak of charges from the photodiode portion 1 to the vertical CCD portion 3 and no leak of light to the vertical CCD portion 3.

The embodiment shown in Figs. 2A and 2B is characterized in that although the entrance gate width  $W_4$  of the readout gate portion 12a and the exit gate width  $W_4'$  of the readout gate portion 12b are the same as those in Fig. 1, the gate width becomes gradually smaller from the photodiode portion 1 toward the vertical CCD portion 3.

The embodiment shown in Figs. 3A and 3B is characterized in that the gate width  $W_4$  of the readout gate portion 12a becomes curvedly narrower from the photodiode portion 1 toward the vertical CCD portion 3.

It will be appreciated that any of these embodiments can bring about almost the same effect as in Figs. 1A and 1B.

Although the present invention preferably applies to the above CCD imaging apparatus, without being limited to it, the present invention is widely applicable to other photoelectric converters used for optical communications or other purposes if they are constructed with a light receiving portion, a gate portion, and a charge transfer portion. The patterns of the readout gate portion can be changed to various ones, and layouts including the shapes and sizes of the portions, and devices constituting the light receiving portion are not limited to the above ones.

WHAT IS CLAIMED IS:

1. A photoelectric converter comprising a light receiving portion, a gate portion, and a charge transfer portion, wherein the gate width of said gate portion is wider at said light receiving portion than at said charge transfer portion.

2. The photoelectric converter according to claim 1, wherein said gate width is narrower from said light receiving portion toward said transfer portion straightly, curvedly, or gradually.

3. The photoelectric converter according to claim 1, wherein said gate portion comprises a first gate portion the gate width of which is narrower from said light receiving portion toward said transfer portion, and a second gate portion provided with an identical gate width from said first gate portion further toward said charge transfer portion.

4. The photoelectric converter according to claim 1, wherein said photoelectric converter is constructed as an imaging apparatus in which said light receiving portion has pixels and said charge transfer portion comprises charge coupled devices.

5. The photoelectric converter according to claim 1, wherein said light receiving portion comprises

photodiodes.

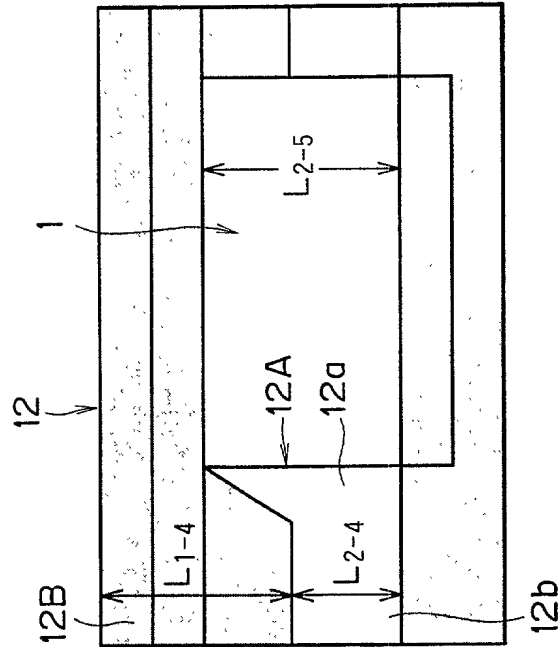
# ABSTRACT

An object of the present invention is to offer a photoelectric converter such as an imaging apparatus which smoothly reads out charges without badly influencing the charge capacity and charge transfers of a charge transfer portion and other characteristics, and reduces power consumption by reducing a readout voltage.

A photoelectric converter such as an imaging apparatus having a readout gate portion patterned to make the width of a portion adjacent to a photodiode portion of a readout gate wider than that of a portion at a vertical CCD portion side.



# FIG. 1A



$$L_{2-4} = L_{2-1}, L_{1-4} = L_{1-1}, L_{2-5} > L_{2-1}$$

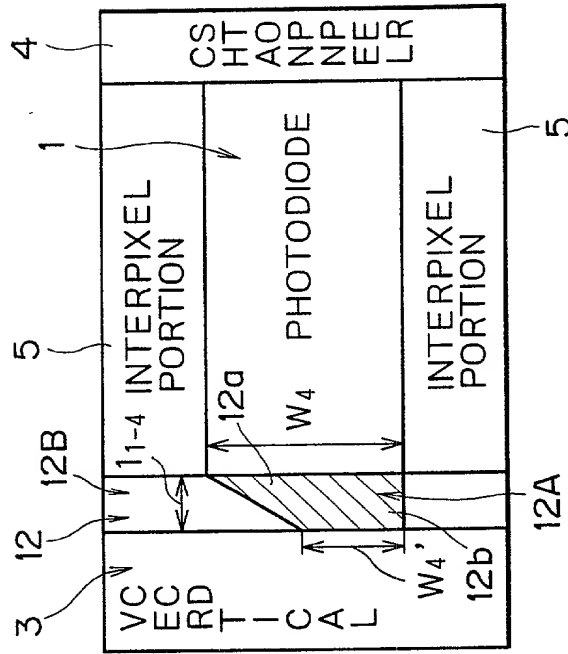


GATE WHICH IS NOT RELATED TO READOUT



READOUT GATE

# FIG. 1B

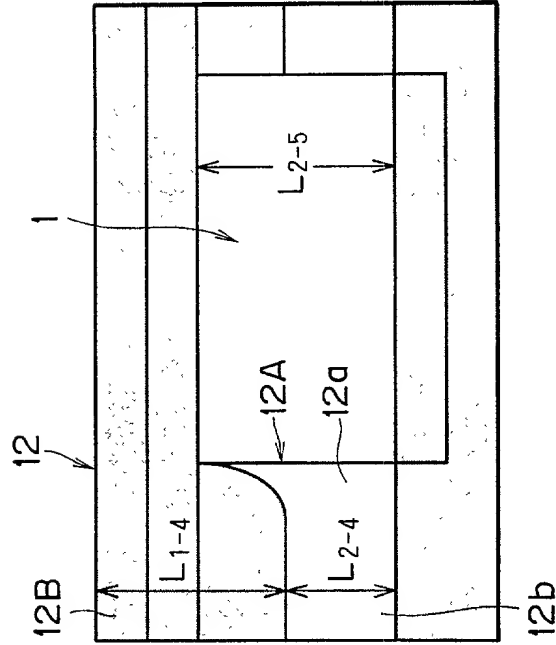


$$1_{1-4} = 1_{1-1}, W_4 > W_1, W_4' = W_1$$

599P13904500



FIG. 3A



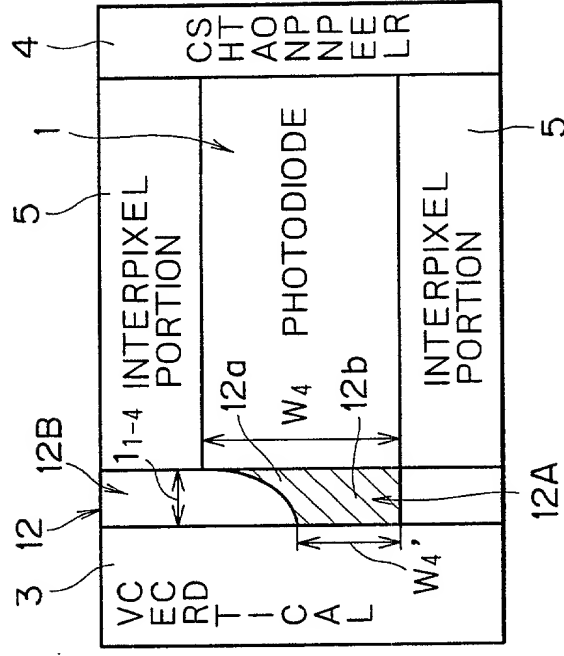
$$L_{2-4} = L_{2-1}, L_{1-4} = L_{1-1}, L_{2-5} > L_{2-1}$$



GATE WHICH IS NOT RELATED TO READOUT

READOUT GATE

FIG. 3B



$$1_{1-4} = 1_{1-1}, W_4 > W_1, W_4' = W_1$$

FIG. 4A

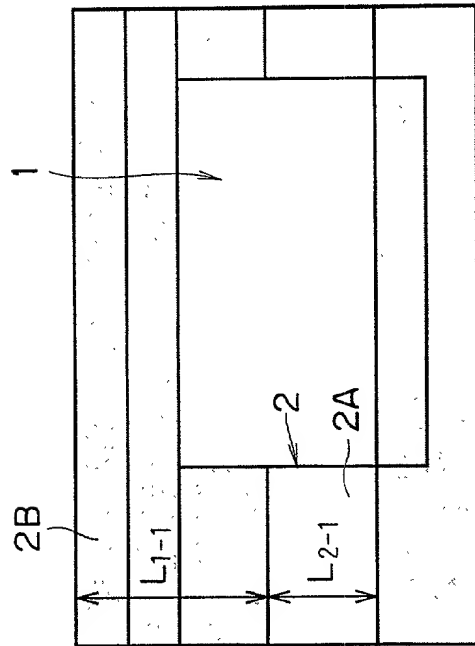
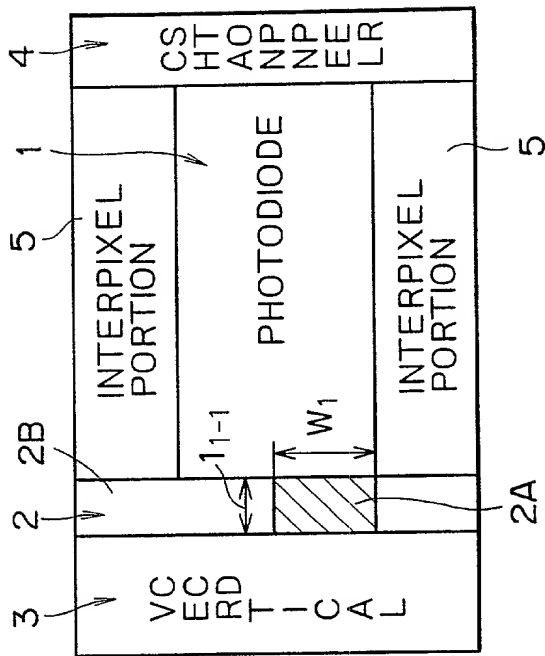


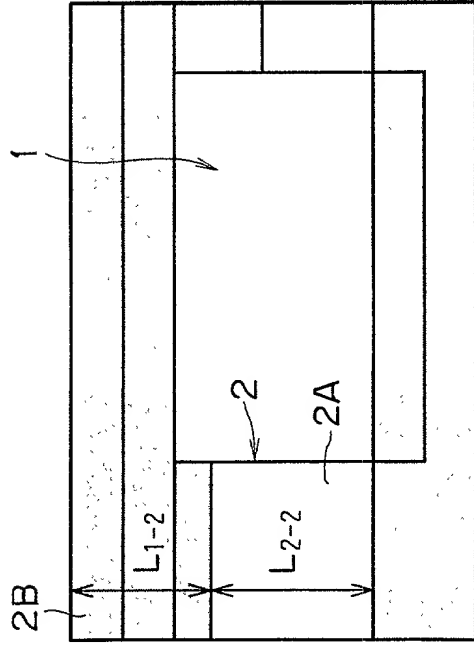
FIG. 4B



□ GATE WHICH IS NOT RELATED TO READOUT

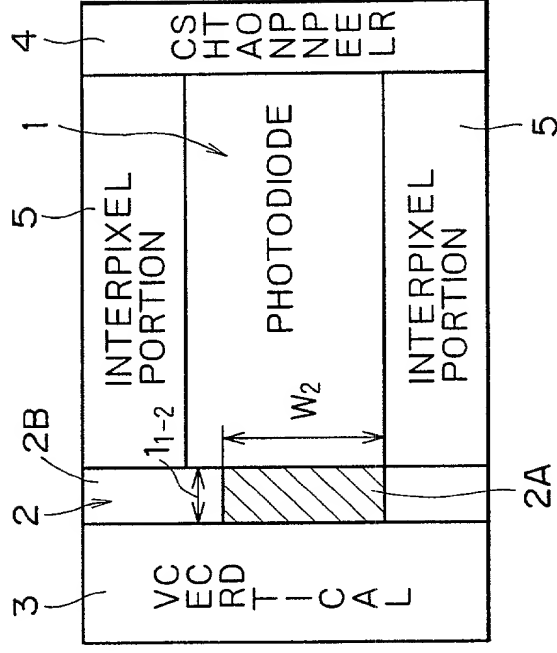
□ READOUT GATE

FIG. 5A



$$L_{1-2} < L_{1-1}, L_{2-2} > L_{2-1}$$

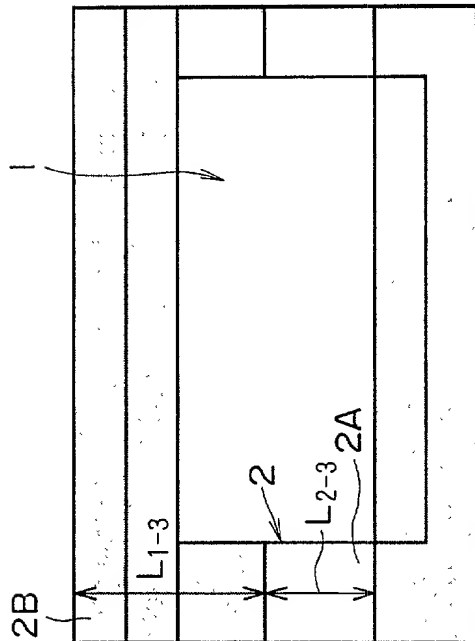
FIG. 5B



$$W_{1-2} = W_{1-1}, W_2 > W_1$$

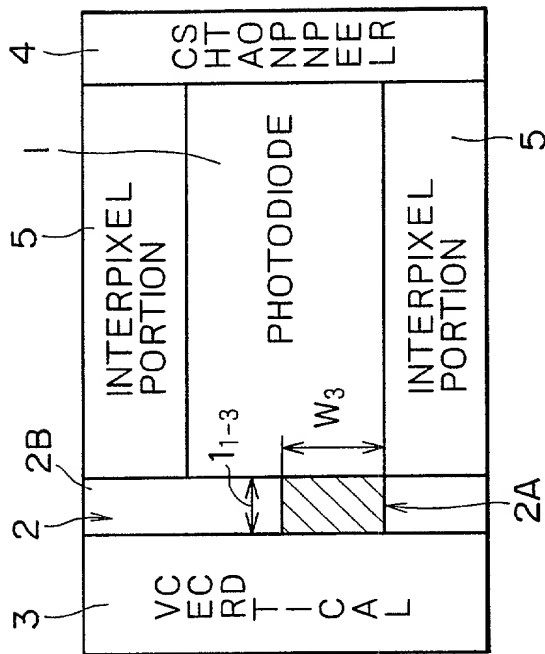
- ☐ GATE WHICH IS NOT RELATED TO READOUT
- ☐ READOUT GATE

FIG. 6A





$$L_{1-3} = L_{1-1}, L_{2-3} = L_{2-1}$$

FIG. 6B

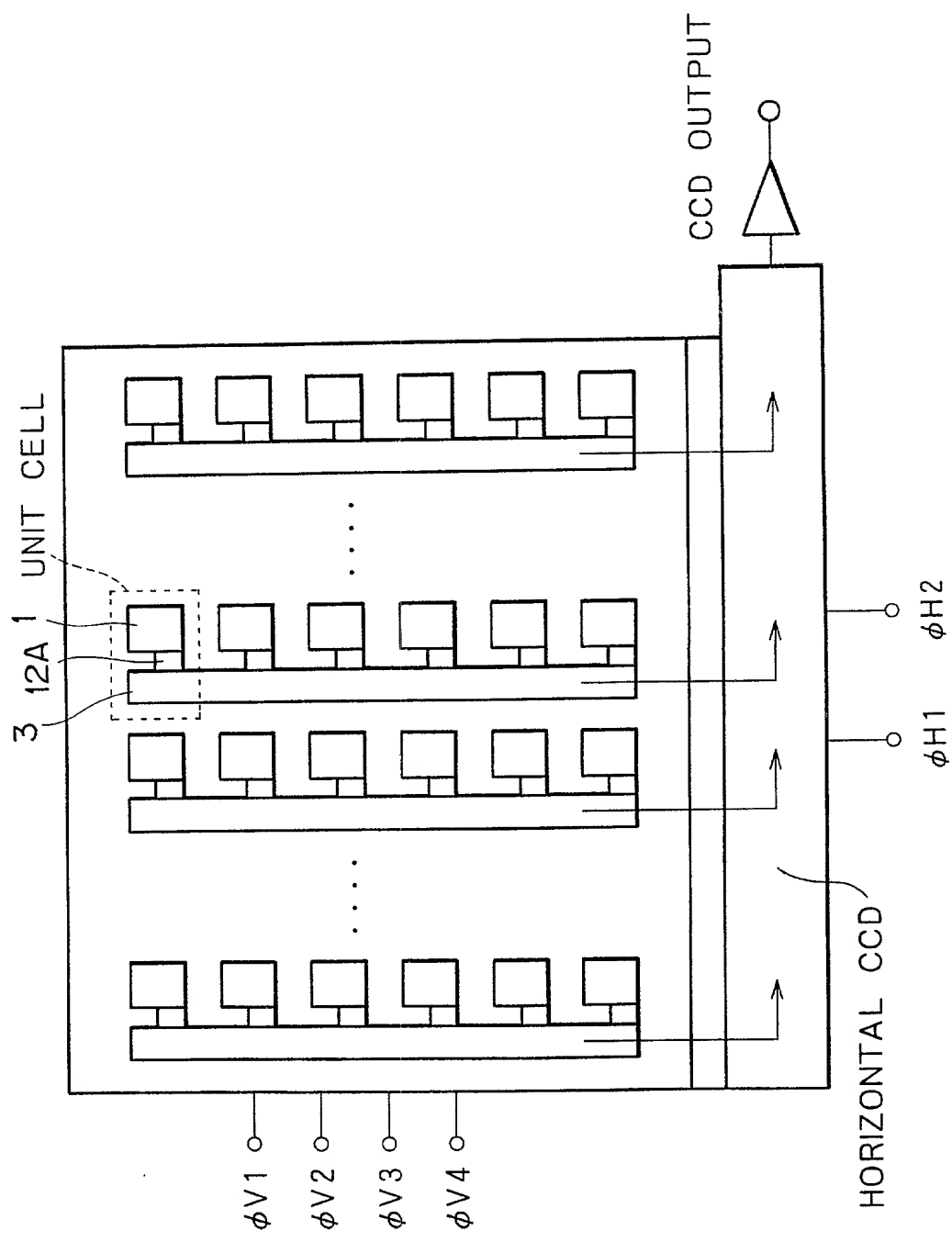


$$1_{1-3} < 1_{1-1}, W_3 = W_1$$

 GATE WHICH IS NOT RELATED TO READOUT

 READOUT GATE

# FIG. 7



## DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

## PHOTOELECTRIC CONVERTER

Case No. P99,2094, the specification of which

(check one) X is attached hereto.  
 was filed on \_\_\_\_\_ as  
 Application Serial No. \_\_\_\_\_  
 and was amended on \_\_\_\_\_  
 (if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims as amended by any amendment referred to above.

I acknowledge the duty to disclose to the United States Patent Office all information which is known to me to be material to the patentability of this application in accordance with Title 37, Code of Federal Regulations, 1.56.<sup>1</sup>

I do not know and do not believe this invention was ever known or used in the United States of America before my or our invention thereof, or patented or described in any printed publication in any country before my or our invention thereof or more than one year prior to this application, that the same was not in public use or on sale in the United States of America more than one year prior to this application, and I believe that the invention has not been patented or made the subject of an inventor's certificate issued before the date of this application in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns more than twelve months prior to this application, and that no application for patent or inventor's certificate on this invention has been filed in any country foreign to the United States of America prior to this application by me or my legal representatives or assigns, except as identified below:

I hereby claim foreign priority benefits under Title 35, United States Code, 119 of any foreign application(s) for patent or inventor's certificate listed below

Prior Foreign Application(s) Number	Country	Date
P10-345559	Japan	December 04, 1998

and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the above listed application on which priority is claimed:

Prior Foreign Application(s) Number	Country	Date
--	---------	------

<sup>1</sup> (b) Under this section, information is material to patentability when it is not cumulative to information already of record or being made of record in the application, and

(1) It establishes, by itself or in combination with other information, a *prima facie* case of unpatentability of a claim; or  
 (2) It refutes, or is inconsistent with, a position the applicant takes in:

(i) Opposing an argument of unpatentability relied on by the Office, or  
 (ii) Asserting an argument of patentability.

A *prima facie* case of unpatentability is established when the information compels a conclusion that a claim is unpatentable under the preponderance of evidence, burden-of-proof standard, giving each term in the claim its broadest reasonable construction consistent with the specification, and before any consideration is given to evidence which may be submitted in an attempt to establish a contrary conclusion of patentability.



If no priority is claimed, I have identified all foreign patent applications filed prior to this application:

Prior Foreign Application(s)

Number

Country

Date

And I hereby appoint Messrs. John D. Simpson (Registration No. 19,842), Dennis A. Gross (24,410), Robert M. Barrett, (30,142), Steven H. Noll (28,982), Kevin W. Guynn (29,927), Robert M. Ward (26,517), Brett A. Valiquet (27,841), Edward A. Lehman (22,312), David R. Metzger (32,919), Todd S. Parkhurst (26,494), James D. Hobart (24,149), Melvin A. Robinson (31,870), Joseph P. Reagen (35,332), Michael R. Hull (35,902), Michael S. Leonard (37,557), William E. Vaughan (39,056) and Lewis T. Steadman (17,074), all members of the firm of Hill & Simpson, A Professional Corporation

Telephone: 312/876-0200 Ext. 3491

my attorneys with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith and direct that all correspondence be forwarded to:

Hill & Simpson

A Professional Corporation

85th Floor Sears Tower, Chicago, Illinois 60606

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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Inventor's signature \_\_\_\_\_ Date \_\_\_\_\_

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Inventor's signature \_\_\_\_\_ Date \_\_\_\_\_

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Full name of third joint inventor,

(if any) TAKESHI SASAKI

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